Research Proposals

CHANGING GROUNDWATER STATUS AND ITS IMPACT ON AGRO ECONOMIC PROFILES IN RAMPURHAT SUBDIVISION OF BIRBHUM DISTRICT, WEST BENGAL

Supervisor

Prof. Sutapa Mukhopadhyay

Submitted By

Amit Kumar Mandal

DEPARTMENT OF GEOGRAPHY

VIDYA-BHAVANA

VISVA-BHARATI

Mukhopadhyay
15/7/18

Professor & Head
Department of Geography
Visva-Bharati, Santiniketan

Introduction:

Groundwater is one of the most valuable water resources in the entire world, especially in the arid and semi-arid regions (Todd et al. 2005; Mukherjee et al. 2012). It is commonly considered as the best quality water for drinking and irrigation around the world (Hoque et al. 2009; Adiat et al.2012). Besides these domestic, agricultural and industrial uses, in situ functions of groundwater is also very much noteworthy *i.e*. feeding the flow of springs, base flow of streams, as well as maintaining the stability of the land surface and preventing the migration of saline water or other poor-quality water into fresh aquifer domains (Gun et al. 2010). Groundwater has several advantages such as consistent temperature, widespread availability, decentralized access, limited vulnerability, outstanding natural quality, low extraction cost, and drought protection capacity (Jha et al. 2007; Arkoprovo et al. 2012). Another quality of groundwater in comparison to surface water is that it is least affected by disastrous events, and it can be tapped when required (Manap et al. 2013). As a result, exploitation of groundwater as alternative to insufficiency and irregularity of surface water is ever increasing (Manap et al. 2013). So in many areas groundwater extraction is exceeding annual recharge resulting in lowering of groundwater table (GOI 2007).

The annual replenishable groundwater resource of the state of West Bengal has been estimated as 29.25 BCM; keeping an allocation for natural discharge, the net annual groundwater availability has been assesed as 26.58 BCM; out of which 10.69 BCM groundwater is extracted annually resulting in 40% of stages of groundwater development (CGWB 2011). Out of 271 assessed units (blocks and Municipal areas), provisionally 53 have been categorized as Semi-critical and 01 as Critical and remaining 217 as Safe (CGWB 2011). Though stage of groundwater development of Birbhum district (32%) is lesser than state average, four blocks namely Rampurhat-II, Murarai-II, Nalhati-II and Nanoor are categorized as semi critical due to alarming lowering of groundwater level; out of which first three blocks falls in Rampurhat subdivision of the district. Besides fluoride contamination is also noticed in the western plateau fringe part of the district made up of igneous hard rock (CGWB 2005).

Apart from environmental and ecological consequences of overexploitation and qualitative deterioration of groundwater, economic dimension is also important (Wani 2009). Excessive withdrawal of groundwater results in increase in pumping depth, decrease in tube well yield, hike in cost of pumping groundwater and widespread and severe scarcity of groundwater in summer month which mostly affects small and marginal farmers who cannot afford the cost of deepening wells long due to their limited economic capacity (Moench 1992; Wani 2009). These cumulative consequences of overexploitation of groundwater resources are emerging as a threat to issues of food security and stability in rural livelihood (Wani 2009).

Under these circumstances, proper understanding of the groundwater dynamics & its interaction with the economic, demographic, socio-cultural aspects of human society is very much challenging issue in front of scientific communities to establish the effective guidelines for the sustainable management of this precious resources maintaining parity between economic performance & ecological balance.

Hypotheses:

All the previous works relating to the theme and area of study are very much helpful in formulation of the hypothesis. From the reviewing of all these previous works following important fact can be presumed.

1. Groundwater level is declining due to indiscriminate exploitation of it through different human occupancies.

2. Quality of Groundwater and its suitability for human consumption and irrigation uses varies spatially due to combined effect of natural hydrogeological settings and human activities.

3. Excessive draft and resultant declining of groundwater level is slowly altering the agricultural landscapes and pattern of rural livelihood.

Objective:

- To examine the spatial and temporal behavior of groundwater in Rampurhat Subdivision.
- To delineate the potential zones of groundwater resources combining all the determining factors of it.
- To examine the quality of groundwater for human consumption and irrigation use.
- To evaluate spatial and temporal circumstances of agricultural landscape.
- To asses impact of changing groundwater dynamics on agricultural practices and rural livelihoods.
- To formulate plan and policies for the sustainable management of groundwater resources

Database:

Data base is very important for conducting any type of research. In this present study data have been collected both from primary and secondary sources.

A. Primary Sources of Data:

Primary data have been collected directly from the field through conducting field survey both during pre monsoon, monsoon and post monsoon seasons. The collected primary data which are incorporated in this work are

- Depth of water level in some wells.
- Information on different layers of aquifer in dug wells and exposed fields of black stone mines.
- Yields data of tube wells and wells.
- Agriculture, Irrigation and land use data of selected eight number of sample villages.

- Socio-economic data of cultivators, agricultural labours and inhabitants of selected eight number of sample villages.

B. Secondary Sources of Data:

Spatial and non-spatial data regarding various aspect of present research work have been collected from different secondary sources, shown through the following table-

Data source	Nature of data
Geological Survey of India	District Resource Map of Birbhum District
State Water Investigation Department	Lithologging Data and Blockwise Average Depth of Groundwater Level from 2000-10
Central Ground Water Board	Groundwater level Data of 33 Wells since 1996 and onwards, Groundwater Quality Data of 33 Wells of 2015
National Atlas and Thematic Mapping Organization	District Planning Map of Birbhum District
Water Resource Information System (WRIS), ISRO	Village Level Rainfall data, Soil Properties Map, Aquifer System Map, Aquifer Thickness Map, Aquifer Material Map
Survey of India	Toposheet map 73 M/9, 73 M/13 and 73 M/14 of 1970-71.
Census of India, 1951 to 2011	Demographic and Socio-Economic Data
National Remote Sensing Center (NRSC)	LISS-III and LISS-IV satellite images
West Bengal Public Health Engineering Department	Groundwater Quality Data, Diagram of Blockwise Depth of Aquifer, Fluoride Affected Map of Gram Panchayats

Indian Meteorological Department, Kolkata	Climatic Data
Statistical and Applied Economics Department	District Statistical Handbook of Birbhum

Methods:

Methodology is the proper way to achieve the desire geographic reality. It is also called the guiding principle of the work. To make a thesis more scientific and justified, expect the traditional surveying, technological aids have been used simultaneously. As per colloquial principles in spatio-temporal empirical research work, research work have been conducted adopting following three principal phases.

1. Pre Field Work:

The objective of this phase is to gain preliminary knowledge about the area under study from the existing reports, literature, maps and diagrams, satellite imageries and areal photographs etc. so that the field work can be carried out systematically. For that purpose the following steps have been pursued.

I. Previous literature and map consultation over the related theme of study.

II. Topographical map consultation and satellite imagery corroboration have been done to understand physical as well as economic landscape of the study area.

III. Collection of information, maps and data regarding the physical background of the area from respective offices and institutions.

IV. Administrative map collection from Census of India's District Census Hand Book and NATMO's (National Atlas and Thematic Mapping Organization) District Planning Map of Birbhum District.

V. Selection of objective oriented geo-environmental properties and socio-economic themes to be stressed on during course of field work.

VI. Framing of field procedure and preparation of questionnaires.

VII. Consultation of mathematical, statistical techniques primarily for data analysis from different research articles.

2. Field Work:

I. Collection of groundwater level data from the office of SWID and CGWB.

II. Collection of Groundwater Quality data from CGWB and WBPHED.

III. Collection of agricultural data from Statistical and Applied Economics Department and ADA office of each block.

IV. Measurement of depth of water level in some wells.

V. Measurement of different layers of aquifer in dug wells and exposed fields of black stone mines.

VI. Measurement of yields of tube wells and wells.

VII. Collection of agriculture, Irrigation and land use data of selected eight number of sample villages.

VIII. Collection of socio-economic data of cultivators, agricultural labours and inhabitants of selected eight number of sample villages through questionnaire survey.

3. Post Field Work

I. All the collected primary and secondary data have tabulated and analyzed through statistical techniques following the objectives of the work.

II. Correlations among different physical and non-physical parameters have established using suitable statistical techniques of correlation and regression analysis.

III. Analyzed data have been presented through different cartographical and statistical techniques viz. SPSS, MS Excel and Origin 15 software.

IV. For graphical presentation, modeling and map generation Arc GIS and Surfer 8 software have used.

Selection of Study Area:

Rampurhat, the most populous subdivision (Census, 2001) of the Birbhum district of West Bengal is situated in the northern part of Birbhum district and extended between 23º52'34"N to 24º33'16"N latitude and 87º34'25"E to 88º00'53"E longitude, covering an area of 1574.23 sq km. (Fig.-1). It is constituted with eight Community Development Blocks namely Murarai-I, Murarai-II, Nalhati-I, Nalhati-II, Rampurhat-I, Rampurhat-II, Mayureswar-I and Mayureswar-II with sixty two Gram Panchayats and two Municipalities namely Rampurhat and Nalhati.

The geological, geomorphological, pedological and climatic settings which are major determinants of groundwater hydrology are of are very much diversified in Rampurhat subdivision. So it may expect that groundwater dynamics of the study area will also be spatially variable.

Rampurhat subdivision is the densely populated subdivision of the Birbhum district where most of populations are engaged in agricultural activities, highly dependent on groundwater based irrigation system.

As per report of CGWB and SWID in Rampurhat-II, Nalhati-II & Murarai-II Blocks of this subdivision, the status of groundwater is 'semi critical' as greater than 50% annual rechargeable water is exploited in different purposes and long term temporal trend of groundwater is showing steady declining trend.

Fluoride contamination beyond the tolerance level prescribed by WHO and BIS, is found in some wells, located in three blocks of this subdivision i.e. Rampurhat-I and Nalhati-I and Mayureswar-I.

So both the quantitative and qualitative status of groundwater of this administrative area is not satisfactory but for domestic and irrigation use peoples mostly reliant on groundwater resources. This background of the study area demands effective scientific investigations.

Literature Review:

Literature Review is the process of reading, analyzing, evaluating and summarizing scholarly materials about a specific topic. In this task of literature review, attempts have been made to find all major books, thesis, reports and articles that have touched upon the subject that are going to study i.e. "Changing Groundwater Status and its Impact on Agro Economic Profiles in Rampurhat Subdivision of Birbhum District, West Bengal". Then all these literatures have been studied thoroughly to get immense idea regarding existing knowledge of the topic, methodology of research work and a lot of perspective. Synthesize of the overview of the previous literature is showing in the following sections:

J. Toth (1963) in his epoch-making article entitled 'A Theoretical Analysis of Groundwater Flow in Small Drainage Basins' has identified three type of flow system in small drainage basin viz. local, intermediate and regional. He has pointed out that higher the topographic relief, the greater is the importance of the local systems and the flow lines of large unconfined flow systems do not cross major topographic features.

David Keith Todd (1980) in his premier book entitled 'Groundwater Hydrology' has outlined different aspects of groundwater dynamics in a systematic way covering occurrence and movement of groundwater, well hydraulics, groundwater level and environmental influence, quality of groundwater and management strategies of groundwater. This book explains all the known techniques to investigate groundwater resources in lucid and simple way.

Ground Water Estimated Committee (1984) recommended different guideline to judge the quantitative & qualitative aspects of ground water. But in 1997 new committee has been established. This committee look into details of the methodology recommended by Ground Water Estimation Committee 1984 and suggests aspects which call for a revision. The new committee updated the recommendation of previous committee and proposed new methodology for the assessment of ground water resources in different hydrological situation and climatic zones.

P. Singh and I. Singh (1996) in their article on Groundwater Depletion in Punjab and Haryana argued that boro paddy in Indian agricultural atlas has got significant place on after green revolution and for this the worst affected states are Punjab and Haryana.

J. Krishnamurthy and G. Shrinivas (1996), K. V. Ravichandran and A. Jeyarem (1997) uses the satellite remote sensing data to delineate the spatial distribution of different ground water prospect classes on the basis of geomorphology and other associated parameters.

International Water Management Institute (2000) have overviewed the global ground water situation and in concluding remarks forecasted that the water vision of a world that future generations will inherit will have to be the one in which groundwater plays its full developmental, productive and environmental role but in a sustainable manner.

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Siddheswar Mukhopadhyay analyzed the geographical, socio-economic, cultural background of Birbhum district in very lucid style and suitably judged the different profiles very reasonably.

Report of CGWB (2005) have indicated that in Rampurhat-II, Nalhati-II & Murarai-II Blocks of Rampurhat subdivision the status of groundwater is ‘semi critical’ as greater than 50% rechargeable water is exploited in different purposes. Besides fluoride contamination beyond the tolerance level prescribed by WHO, is found in the three blocks of this subdivision i.e. Rampurhat-I , Mayureswar-I & Nalhati-I.

A. Muthukrishnan & V. Manjunatha (2008) adopted Remote Sensing & GIS based methodology to identify the suitable sites for artificial recharge zone where over exploitation of ground water resources leading to the continuous exhaustion of ground

water aquifers. Weighted Index Overlay Analysis (WIOA) is applied to delineate ground water perspective zone.

S. Pal (2008) in his doctoral thesis entitled "An Appraisal of Geo-economic Environment of Major Wetlands Within Kandi Block, Murshidabad District, West Bengal" has clearly indicated the steady depletion of groundwater with increasing agricultural intensity in Kandi block of Murshidabad district of West Bengal. His findings point out that gradual growth in groundwater based boro paddy cultivation leads to increase in seasonal and temporal fluctuation of groundwater level.

Sreela S. R. (2009) in her doctoral thesis entitled 'An Integrated Study on the Hydrogeology of Bharathapuzha River Basin, South West Coast of India' has analyzed the spatial and temporal behavior of groundwater system in concern study area. She has made intensive geophysical survey to explore different attributes of sub surface hydrogeology. She has applied different quantitative methods to estimate recharge and draft of groundwater; and to asses infiltration rate and groundwater balance. She has accumulated a lot of necessary data base using GIS technology to delineate groundwater potential zone for sustainable management of this precious resources.

Subhajyoti Das (2011) in his book entitled 'Groundwater Resources of India' has outlined consize overview of groundwater occurrence, development, conservation, management and related issues in India This book is a compilation and synthesis of voluminous information, lying scattered in various departmental publications, books, seminar proceedings, reports, articles etc.

P. Das (2013) in her doctoral thesis entitled "Hydro-Geomorphic Characteristics of Kuya River Basin in Eastern India and Their Impact on Agriculture and Settlement" has estimated lowering of groundwater level at the rate of 18 cm per year and has denoted that growing water lifting from underground storage is largely responsible for such steady water lowering rate. A negative relation between depth of groundwater level and water yield both during monsoon and pre monsoon season is observed in her research findings.

A. Majumdar and L. Sivaramakrishnan (2014) explored that Pandua Block of Hugli district in West Bengal is a semi critical block in terms of groundwater budgeting. They show ground water budgeting of this block through the calculation of recharge and draft of ground water. They also identified that fall of groundwater level of the block is not absolutely due to groundwater drafting but lithology also responsible for groundwater budgeting.

Deepesh Machiwal and P. K. Singh (2015) have used multivariate statistical analysis (Principal Component Analysis and Cluster Analysis) to identify major determining factors of groundwater level in hard rock terrain of Udaipur district, Rajasthan. Their findings indicate that the groundwater level is fairly influenced by rainfall occurrence and topographic variability in the area.

S. P. Rajaveni K. Brindha and L. Elango (2015) have studied the geological and geomorphological controls on groundwater occurrence in a hard rock region and concluded that origin, movement and existence of groundwater depends on several factors such as slope, drainage density, land use, geology, lineament density and geomorphology.

Yennam Chinnaiah (2015) in her doctoral thesis entitled ‘Analysis of Groundwater Levels and Water Quality in Musi River Basin, Telangana State’ has attempted to estimate rainfal recharge, rainfall infiltration, groundwater draft, change in groundwater storage and Ground water balance using different quantitative techniques in upper musi catchment. She has prepared water level contour map and rainfall distribution map to obtain relationship between rainfall and groundwater level. She has explained declining long term trend of groundwater level as a result of excessive withdrawal.

N. Das (2016) in his doctoral thesis entitled “Hydrological Behaviour and Socio-Economic Impact of Wetlands on Labpur Block, Birbhum District” has pointed out that over exploitation of ground water for the production of HYV seeds as well as detorioration of wetlands and irregular rainfall pattern are hampering the ground water layer. His findings denote negative relationship between depth of groundwater level and yield of tube well or well.

Relevancy of the Theme:

Groundwater has an important role in the environment: it replenishes streams, rivers, and wetlands and helps to support wildlife habitat; it is used as primary source of drinking water and also in agricultural and industrial activities. Inhabitants of this rural area are highly dependent on groundwater resources for domestic and agricultural use which leads to over withdrawal of this resources causing decline in groundwater level and deterioration of quality of groundwater. This trend of excessive draft of groundwater results in increase in pumping depth, decrease in well yield, hike in cost of pumping and failure of pump during dry season which altogether hampers the agro economic scenario of the study area. From this perspectives collecting, processing, analyzing and presenting necessary data relating to groundwater dynamics and quality of groundwater; anticipating trends of change in groundwater quantity and quality; and assessing impact of these events on agricultural practices which are the base of economy of this area will be very much time worthy and relevant. This study attempts to provide significant information, maps, diagram, model etc which are necessary to the broader society for planning, policy and management of groundwater resources.

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